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REMOTE STORAGE

HARRIS. (SNOW)

PROTECTION OF THE BRITISH NAVY

FROM

LIGHTNING

1838

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STATE OF THE QUESTION

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6/18/31*

RELATING TO THE

PROTECTION OF THE BRITISH NAVY

FROM

LIGHTNING;

BY THE METHOD OF

FIXED CONDUCTORS OF ELECTRICITY,

AS PROPOSED


BY MR. SNOW HARRIS, F.R.S., &c.



PLYMOUTH:

T. J. BOND, WHIMPLE-STREET.

1838.



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REMOTE STORAGE

PREFACE.

THE following pages have been printed for the sake of perspicuity, and to avoid the trouble generally attendant on the perusal of written documents : they have not been published.

In pointing out the actual state of the question of the defence of the navy from lightning, the author has simply and plainly stated certain facts in his possession connected with it ; with a view of shewing its influence on the naval and commercial interests of the country, on the existing state of our national science, as having strong claims to public consideration ; and lastly, its relation to himself. And be it remembered, that the question the author here proposes to discuss, is one of no small moment : it is a question actually involving the protection of the navy and shipping generally of this country, together with the lives of our seamen, and the property of our merchants, against one of the most fearful and destructive agencies in nature ; and to the effects of which, they are every day exposed.

This important subject not having received that consideration to which it is fairly entitled, the author seeks to obtain a rigid examination into the facts relating to it, by a Committee of the House of Commons ; as in the case of the enquiry into the source of shipwrecks, lately instituted by a committee of the house, and in which, this question might fairly have been included. When the circumstances he has detailed, shall have been calmly weighed, he cannot but believe, that every member of the house will concur in the propriety of their being submitted to a similar investigation.

Elect. Engine. 20731 Drafton

757947

STATE OF THE QUESTION

RELATING TO THE

PROTECTION OF THE BRITISH NAVY

FROM

L I G H T N I N G .

1. SHIPS are liable to be wrecked, burned, or otherwise destroyed, in consequence of discharges of electricity from the atmosphere. The official log-books of the British Navy, and the ordinary journals of the merchant service, place this beyond a doubt. They exhibit a loss of life, of property, and services of ships at critical periods, to an extent not generally appreciated ; and, at the same time, lead us to conclude, that many missing ships may have fallen victims to the unsparing hand of lightning.

2. Although the full amount of the damage sustained does not seem to have undergone any rigid examination, still the question has been deemed of sufficient consequence to arrest the attention of the principal maritime countries of Europe: and persons of high attainments in science have, from time to time, endeavoured to protect shipping from this source of danger. The plan generally suggested, viz: that of leading small conducting chains or links of metal, from the mast head along the rigging to the sea, seems to have been in some way incomplete, inasmuch as the damage has continued in ships to a fearful extent, notwithstanding that buildings on land have been successfully defended.

3. In the year 1820, Mr. Snow Harris investigated, practically and theoretically, the general question, and proved that, if the ordinary means of defence resorted to on shore could be carried out on ship-board, in all its generality and efficiency, we should have no longer to lament the loss of life and property so common to the effects of lightning at sea. He has shewn how the fixed and more massive conducting rods suggested by Franklin and other philosophers, may be rendered applicable under another form to the variable positions of a ship's mast: that these being united to a perfect system of conduction

throughout the hull, would necessarily obtain for shipping all the protection which, on admitted principles in science, could possibly be hoped for.*

4. Mr. Harris's views, on being made known, received the approval of eminent scientific men ; and, after some preparatory discussion, the sanction of the Admiralty. They were carried into effect in ten ships of the British navy, viz: four sail of the line, three frigates, two small class frigates, and a brig. Thus, the conductors have been tried, from the largest ship in the navy to nearly the smallest ; from a ship of 120 guns, to a small brig of 10 guns. The result of twelve years' experience has shewn, that what Mr. Snow Harris advanced, was not only sound in philosophy, but available in practice, as the written testimonies of several officers in command of the ships clearly prove ; whilst accredited estimates from a naval engineer, acting under the direction and on the part of government, shew, that the expense of defending our navy from lightning is really small.

5. Do we, then, require the sentiments of men of acknowledged scientific learning ?—We have the recorded opinions of such men as Wollaston, Davy, and Young, and also of Brewster: we have the frequently expressed approbation of almost every man of practical science who has ever considered the question—not excluding such men as Faraday, and the late Dr. Turner.

Do we require evidence from experience ?—Then we have the facts before us, deducible from the voyages of the ships in which the conduct-

* Mr. Harris's system consists in substituting for the small copper links furnished as lightning conductors to the navy—massive and fixed lines of metal to be identified, by a particular method, with the masts ; so as to insure one continuous line of conduction from the Truck to the Keelson : these are finally connected with all the metallic masses in the construction of the hull, and with the various metallic bolts, passing into the sea. The objection to the small linked chains—at present intended to be set up temporarily, as occasion may require—is, that they are seldom in place, and are liable to every kind of damage incidental to a ship's rigging in gales of wind, especially at night, when it is requisite to remove some portion of the masts, either in consequence of accident, or by design. Their want of continuity of dimension, are both unfavorable to the rapid dissipation of heavy electrical discharges. Moreover, being packed in a box, they are commonly stowed away in the ship's stores, and are seldom ready until they are no longer required. The enormous mass of damage sustained by shipping, during the time that buildings on land have been defended, shew how little they can be relied on, in their practical results at least

Now the advantages of the system resorted to by Mr. Harris are these : the conductor is massive and continuous, and always in place ; hence, it is ready to meet the most unexpected danger ; it does not require, like a chain or rope, a constant watching and looking after, to the great annoyance and dread of the seamen—but takes care of itself. It remains perfect under any new position, or under any damage which the mast may sustain ; can resist great external force ; and may be shewn to be adequate to the dissipation of the most powerful discharges of lightning yet experienced in ships.

For a detailed exposition, see the accompanying papers on the Defence of Ships from Lightning, marked A ; or Nautical Magazine, Old Series, Vol 3 ; or New Series, Vol. 1.

ors have been tried ; beside which, their application rests upon scientific principles ; acted upon in this and other countries, in the defence of powder magazines and other buildings on shore, for more than half a century.

Do we consider the application on the ground of economy ?—Then we have before us, documents which prove the very great loss in money sustained by the country, and the little comparative expense requisite to avoid it.

Do we view the question on a principle of expediency ?—We have instances of damage sustained by our fleets during times of emergency, which, in a variety of cases has deprived the country of their services for a considerable time.

Do we consider the subject as relates to humanity ?—We observe a loss of life or bodily injury sustained by our seamen to a very serious extent.

6. There is really not a single point in the present state of this question which has not a clear and definite position : it has, in fact, been brought within very narrow limits ; e.g. experience having shewn that it is possible, by a simple application of practical science, to defend the navy of Britain—the right arm of her power, from one of the most fearful contingencies to which it can be exposed. Query. Is it worth while to avail ourselves of it ? Absurd as it may appear, it seems by the fact, that it is not considered worth while : for, notwithstanding that eminent scientific men have given their opinions *in favor* of the fixed conductors ; that they have been *tried for many years and proved efficient* ; that the expense of fitting them is *small*, and the *method easy* ; that they have gained so much in the good opinion of the navy, as to lead many officers to apply for them : notwithstanding all this, and the important relation of the subject to the naval and commercial prosperity of the country, it will be found on enquiry, that this system of defence, instead of receiving fair encouragement, may be considered as virtually abandoned : when the ships in which the conductors were placed were dismantled, the metallic plates were torn out of the masts, and unconcernedly thrown by as old copper, whilst many applications for the conductors, from officers in command of ships, have been refused. Thus, a great national experiment, involving the *lives of our seamen* and the safety of our fleets, has been quietly laid aside without any *assignable reason—without enquiry* : an experiment which has occupied, to a greater or less degree, the attention of the scientific part of Europe for upwards of seventy years, and which, in its relation to humanity alone, has the strongest claims to consideration.

Such is the state of this question in relation to the naval interests of the country.

7. Now as regards Mr. Harris, it may be observed, that in perfecting this system of defence from lightning on ship-board, he has incurred,

not only a very serious responsibility, but a very heavy expense in various ways. It cannot but be admitted, that if any damage had happened, either to the ships fitted under his direction, or to the buildings at the new Victualling Office at Plymouth, which have been also protected under his inspection, at the request of Sir John Rennie, acting under the Admiralty, Mr. Harris would doubtless have been held responsible.

8. It is not Mr. Harris's wish to bespeak any personal favor, nor does he desire to have any thing taken for granted merely upon his own statements: aiming at nothing which may not come fairly and openly before the country, without any kind of reservation whatever, he seeks a rigid and impartial enquiry; not more from any individual interest he may be presumed to have in this interesting question, than from a desire to promote the advance of general science, and defend our fleets, together with the lives of our seamen, from one of the most destructive natural agencies to which they are so frequently exposed.

Under these impressions, Mr. Harris is led to hope that he may obtain, by means of a committee of the House of Commons, that due consideration of this question, to which he cannot but feel it is justly entitled.

ELEMENTARY FACTS.

9. Should such an inquiry be obtained—the following are three elementary points requisite to be verified.

Can it be proved that the damage sustained in the British navy, and by shipping generally, is really such as above stated?

Can it be shewn that this damage may, in all probability, be avoided by a simple and practicable system?

Has not this system been virtually abandoned, without any apparent reason, to the great disadvantage of our naval and commercial interests?

PROOFS.

10. The documents relating to the first of these points, viz, the amount of damage sustained by our shipping, will be found in the appx. sec. A, which contains a record of 174 cases of damage by lightning in the navy, being a *part only* of that which has occurred since the commencement of the war 1793. In about 100 of these cases, of which the particulars have been fully ascertained, it appears, that one sixth of the ships were set on fire in some part of the sails, masts, or rigging; in *one half*, *some of the crew were killed or wounded, or both*. The total numbers are, *62 seamen killed and 114 wounded*: this is exclusive of one instance, in which the number of seamen killed is denoted as several; and of another, of a frigate of 44 guns, totally destroyed, and in which nearly all the crew perished: it is also exclusive of 12 cases in which the wounded or hurt were set down as several. Beside these

calamitous results, we find a general panic and impression made on the minds of the sailors, in some instances ruinous in the extreme : thus, in the case of the *Theseus*, of 74 guns, on the blockade of Cape Francois, (No. 166) it appears, the people rushed up the hatchways, and were with difficulty prevented from jumping into the sea. Also, in the case of the *Cambrian*, off Plymouth, (No. 31) Capt. Haydon, of the navy, who was at the time in the ship, gives the following account of it : he says, “ a ball of fire struck the top-mast-head and passed by the top-sail-sheet to the bits, where it killed two men and wounded many others ; from thence it passed into the waist, striking down almost every one on that side of the deck ; the number of wounded men taken below, many of whom were insensible, was about *twenty* : one became totally blind, another blind and speechless. The appearance of the ship at this moment was distressing in *the extreme*, nor could the men for many months get rid of the impression produced on them, whenever the atmosphere seemed charged with the electric fluid.”

A similar result ensued on board the *Repulse*, of 74 guns, (No. 126) struck by lightning in the Mediterranean ; in which case, 11 men were killed, and 10 wounded. The author has been informed, by an officer of the navy, then in the ship, that a great alarm prevailed amongst the seamen for some time after, whenever lightning presented itself. Indeed, the effects of lightning on our seamen was so dreaded in the fleet under Lord Exmouth, off Toulon, that his Lordship gave a general order, that the men were not to be sent aloft during the prevalence of lightning, except in cases of great emergency.

11. The loss in money on account of these 100 cases *only*, must, taking into account the detention and refit of the ships, have amounted to some hundred thousands of pounds. There appears to have been damaged or destroyed 43 lower masts of line of battle ships, 29 lower masts of frigates, top-masts and other spars in proportion.

12. The loss in services of ships at critical periods, is strikingly illustrated by cases, 19, 36, 38, 57, 60, 69, 137, 143, 161, 166. The most important of these are the following : No. 57—the *Glory*, 98 guns, one of Sir R. Calder’s fleet, disabled a few days before meeting the combined fleets of the enemy. No. 60.—Mediterranean squadron under Sir. J. B. Warren, nearly all damaged, some disabled, after a refit at Port Mahon, and immediately it had sailed in pursuit of the French fleet, under Admiral Gantheaume, then just passed into the Mediterranean. It is stated in a letter from Admiral White, then captain of the flag-ship, the *Renown*, “ that the fleet suffered more in spars, than would probably have occurred in a general action.” No. 69.—The squadron at Buenos Ayres, for the protection of our trade in south America ; out of five ships, two, the *Heron* and *Thetis*, were disabled and obliged to shift lower masts. It appears, by a letter from Capt.

the Hon. F. Grey, then commanding the *Heron*, that for some time "convoys could not be granted to our merchant ships in consequence."*

No. 137. In this case, out of 13 sail of the line on the blockade of Toulon under Lord Exmouth, 7 ships were damaged at the same time, and more or less disabled.

No. 166. The *Theseus*, 74, on the blockade of Cape Francois, obliged to leave her station. Beside these, many others will be found deserving of serious attention.

13. A full exposition, however, of the facts relating to this point being given in appendix, sec. A, it is unnecessary to dwell upon them here; it may not, however, be amiss to notice the following extract of a letter from Lieut. Brady, of the navy, published in the *Nautical Magazine* for December, 1834, as having an immediate reference to the question under consideration.

"To the Editor of the Nautical Magazine."

"SIR, As I do not know Mr. Harris's address, who has lately written on *Lightning Conductors*, in the *Nautical Magazine*, I shall feel obliged if you will insert, for his information, the subjoined account of a series of accidents which befell H. M. ship *Cumberland*, from lightning."

"On the 25th of August, 1810, the *Cumberland*, 74, Capt. Hon. P. Wodehouse, being at anchor near Faro Point, Sicily, about midnight was struck by lightning, which ruined the main-mast, and set the fore-top on fire. The main-mast was surveyed and condemned, *but as the ship was employed on a service that would not admit of diminution of defensive force*, and was also of a nature to keep her stationary, it was determined to *fish* the mast. This work was in progress of completion, when, on the third or fourth day, soon after eight A. M. the same devoted spar was again struck, and received such additional injury, that, separately considered, the effects of the second stroke was as fatal as that of the first to the efficiency of the mast, *and the ship was forthwith sent to Malta for a new one*. On the 25th of February, 1812, the *Cumberland*, Capt. Thomas Baker, off Torbay, in a gale of wind, about noon, was again struck on her main-mast; several perforations caused by the electric fluid, were plainly visible, some of the iron hoops were burst asunder, and this mast was also rendered unserviceable. The above relation affords a strong auxiliary plea in favor of his (Mr. Harris's) invention being submitted to an extensive course of experiment, on the score of economy alone, when the value of two main-masts for a seventy-four gun ship, at the time referred to, is considered."

August 4th, 1834.

"W. H. BRADY, Lieut. R. N."

* It is not unworthy of remark, that Sir J. Phillimore, before in command of the *Thetis*, strongly impressed with the necessity of having the new conductors in his ship, made a strenuous application for them; the ship, as he stated in his letter, being likely to visit places where damage by lightning is not unfrequent. His request was refused, and the consequence was, that in a short time after, the ship *lost her foremast* on a foreign station, where it became *difficult to replace it*.

The following are extracts from the letters from Capt. the hon. F. Grey, R. N., and Admiral C. White, before alluded to; these are likewise of too much importance to be passed over without due notice. The former was addressed to the author, the other to Capt. Beaufort, hydrographer to the Admiralty.

“Whilst lying off Buenos Ayres on the 9th March, 1828, at 10, P.M. the *Heron*, then under my command, was struck by lightning, which cut the fore-top-mast back-stay close to the mast head, passed through the slings of the fore-top-sail yard; it shivered the yard, and burned part of the royal and top-gallant sails which were in the top-mast rigging; it then passed through the heart of the fore-mast, so that on our return to Rio Janeiro it was requisite to get a new one. Whilst lying at Rio without our foremast, on the 8th of April, the *Thetis* frigate was also struck; her fore-mast and fore-top-mast were completely shivered: thus, out of *five* ships of which the squadron consisted, and at a period when *in consequence* of the war *between the Brazils and Buenos Ayres, their services were particularly required for the protection of our trade, two were for a considerable time disabled.*”

“The squadron under Sir J. B. Warren, consisting of the *Renown*, *Dragon*, *Haerlem*, *Gibraltar*, *Hector*, *Genereux*, *Phoenix*, and *Mercury*, sailed for Mahon early on the morning of the 24th of February, 1801: about two P. M., we were overtaken by a violent thunder storm, in which all the ships suffered, more or less. The *Genereux* lost fore and main-top masts, and sprung her main-mast; the *Mercury*'s main-mast was damaged by the lightning, and I think she had a man or two killed; the *Phoenix*, also, I think, had some of her people struck; in the *Renown*, our mizen-mast was struck: in short, the squadron had scarcely left the Port, when we sustained as much or more damage in our masts, than would probably have occurred in an action with the enemy, so that we were obliged to return and refit. If you can get at the logs of some of the sufferers, you will doubtless obtain more information.”

“I will enclose an account which I have cut out of my paper, of the destruction of a ship by lightning. An exactly similar case occurred to an American ship, loaded with cotton, from Charlestown to Liverpool, in which Sir Isaac Coffin was a passenger; I am sure he would give you the particulars of his providential escape in the boats.”

14. Such are the consequences of damage by lightning in the navy. If we turn to our commercial marine, we find it equally serious; thus, within a few years, several large ships have been burned, and their rich cargoes totally lost. The ship *Logan*, was burned in this way in 1832, having on board 75,000 dollars; also, the ship *Ruthelia*, in January last. Numerous merchant vessels of great commercial importance, have suffered so severely, that it is surprising the attention of the

insurers is not more directed to the amount of property destroyed ; as a powerful illustration, it may not be out of place to notice, briefly, the following extract from the protest of the master of the *Orwell*, lately struck by lightning, on her voyage from New Orleans to Liverpool.

EXTRACT FROM THE PROTEST OF ALEXANDER GOW, MASTER OF
THE ORWELL, ON A VOYAGE FROM NEW ORLEANS,
TO LIVERPOOL.

15. "That on the 19th of February, 1838, it blew very hard from N.W., with heavy squalls and rain ; the gale continued all night, and was accompanied by a great deal of thunder and lightning : that at half-past two, P.M. on the following day, (20th February) the ship was struck by the lightning, which set fire to, and burnt nearly the whole of the sails, did considerable damage to the masts, spars, and rigging, and knocked down the master and several of the crew : that the heavy rain soon extinguished the fire in the rigging, but immediately afterwards they found, that the vessel was on fire in the lower hold, and that the spare sails in the cabin were also burning : that all hands were immediately set to work to cut away the cabin and deck to get at the fire ; and, finding it increasing, they hove down a quantity of water amongst the cargo, at the same time throwing every thing overboard that came to hand in the cabin : that after cutting through into the hold, they found several bales of cotton on fire, and in order to get this extinguished, they had to throw some of the cargo overboard ; that after great labor and exertion, they at length succeeded in getting the last bale of cotton that was on fire from the bottom of the ship, about ten or eleven P.M. ; and all hands were then set to work at the pumps, as the vessel was making a great deal of water : that at eleven, A.M., on the 21st of February, the vessel *was struck a second time by the lightning, which shivered the main-mast, main-top-mast, and main-top-gallant-mast, and damaged the larboard pump.*"*

16. Although such instances have not an immediate reference to damage sustained by H. M. ships, they have still a most important relation to our commerce, and are essentially involved in the consideration of

* "She had on board, two excellent chronometers, which were so strongly magnetized as to be totally useless. Almost the entire of the steel work had to be changed ; the pendulum springs and other parts of the steel work would carry small pieces of iron and steel. The greater part of the watches, if not the whole, were magnetized in the same way.

The compasses on the contrary, were completely divested of all kind of magnetic touch—would run round and stop at any point whatever : the only compass on board that retained any power, was the cabin compass."

"Signed, J. L. S. WALKER, Optician,
34, South Castle-street, LIVERPOOL."

Similar results occurred on board the packet-ship *New York*, severely damaged by lightning in 1827 ; an account of which will be found in the *Liverpool Chronicle* for May, of that year. See also the *Times* newspaper of the same time.

the general question. It is quite apparent, that whilst any plan for avoiding damage by lightning is discountenanced in her majesty's service, it is very unlikely to be adopted by others: hence, if the plan be really an efficient one, and discouraged without good cause, the result is highly detrimental to our merchant ships, as well as to our seamen generally, who, labouring under false impressions, and a vulgar prejudice, still continue, the one to lose their lives, the other, their property, when both may be saved at a small cost.

17. The documents relating to the second point, viz, the possibility of avoiding the damage above-mentioned by Mr. Snow Harris's method, will be found in the appx. sec. B. To these have been added, the opinions of naval officers and others who have considered the subject, and who have witnessed the effects of lightning on ship-board: it also contains the opinions of several individuals distinguished for their talents and ability, who have given the subject their valuable consideration; although it is admitted, that the merits of any principle in practical science can only be substantiated by an appeal to facts, still, such testimony is not without its value. Beside these documents, this portion of the appendix contains the substance of the report by Mr. Rice, made by order of the commissioners of the navy in 1831, relating to the expense and practicability of the plan.

18. It cannot but be apparent on an impartial review of these documents, that no good reason exists for *discarding* Mr. Harris's system of defence against lightning from H. M. Navy, since it is clearly proved to be, first—consistent with the safety of the ships and welfare of the service; secondly—with the mechanical conditions of the masts; thirdly, with a just economy; lastly—it is expedient.

19. The documents relating to the last point are given in appx. sec., C. These are supported by the notorious fact, that scarcely a ship in the navy now remains equipped with the conductors; and that applications to obtain this protection from lightning have been commonly refused. It is, however, proper to state, that after some representations made, through Sir J. Barrow, to the admiralty, a small frigate, the *Acteon* had the conductors *replaced* on her masts at Portsmouth, without the inventor's sanction or inspection of the work; hence, if any failure arose, either in its practical or scientific details, the cause of such failure would probably have been attributed to some defect in Mr. Harris's method; whilst the credit of any success would, on the contrary, have rested with those who carried the plan into effect. This, to say the least of it, was not dealing generously with Mr. Harris, and was at the same time unjust to the service. It was either prudent to *fit* this ship with the *new conductors*, or it was not: if the former, then, as a measure involving serious responsibility, it should have been carried out under the eye of the inventor, and not left to the care of persons neces-

sarily new to the work:—if the latter, it should have been set aside altogether. Further, in applying the conductor to a single ship in this way, more than an average expense is incurred. Mr. Harris feeling that he was, to a certain extent, responsible for the success of this measure, addressed an official letter to the Lords of the Admiralty through Sir John Barrow, pointing out these circumstances. The reply given did not meet the case, and was to a certain extent extremely indefinite: it simply stated, that Mr. Harris had permission, if he pleased, to go to Portsmouth and attend the fitting of the *Acteon*: but as this could not be done except at great personal inconvenience and considerable expense to Mr. Harris, it amounted almost to a refusal, and was, in other respects, very like a skilful parry of the question under consideration.

20. In order to the complete elucidation of every thing likely to come under consideration, the author has, in the appx. sec. D, been led to notice an extract of a letter from the officers of the Plymouth Yard, and with which he was honored by order of the Lords Commissioners of the Admiralty, together with the reply and explanation.

The history of this affair is very brief: it appears, that in consequence of Mr. Harris's suggestion, a report was called for on the state of the spars of the *Caledonia*, of 120 guns, soon after she was dismantled at Plymouth; in which ship, his system had been employed for upwards of seven years. It was notorious at this time, that so far as the conductors were concerned, the spars were as good as when first issued—in fact, many of them had been returned into the store as serviceable masts, &c., to be re-issued. Those, however, thus *returned as serviceable*, were speedily defaced for some unintelligible cause, by the gratuitous stripping of the conductors out of the spars. This uncalled for proceeding led to the extract in question, which, it should be understood, was a *portion only* of a report favorable to the use of the conductors, the rest having been withheld. Mr. Harris's reply seems to have been quite satisfactory, since their lordships offered no further remarks.

21. Finally, sec. E of the appendix consists of a paper explanatory of the general question; which the author was led to submit to the consideration of the First Lord of the Admiralty.

It was not without regret that Mr. Harris found that Lord Minto was indisposed to entertain the question, or allow, on account of an alleged interference with the functions of the Board of Admiralty, any enquiry in Parliament, notwithstanding that his lordship had, on a former occasion, expressed himself perfectly satisfied with Mr. Harris's expositions. It is with all due respect, that Mr. Harris is led to question both the policy and justice of such a decision on the part of the First Lord of the Admiralty, to whom is entrusted the welfare and safety of the navy; and therefore hopes, without being open to any charge of presumption, or

to any undue interference with the naval administration of the country, he may fairly claim to have a free and full enquiry, by means of a Committee of the House of Commons, into a subject intimately affecting the maritime interests of Britain;—a measure which has not unfrequently been resorted to in similar cases, as in the enquiry into the cause of shipwrecks, &c.

STATE OF THE QUESTION RELATING TO
THE PROTECTION OF THE BRITISH NAVY
FROM LIGHTNING.

APPENDIX.

SECTION A.

CASES OF DAMAGE BY LIGHTNING

IN THE BRITISH NAVY.

INTRODUCTORY.

THE following cases of damage by lightning in the British navy are arranged alphabetically; they have all occurred, with two exceptions, since the commencement of the war in 1793: by far the greater number have happened within thirty years, viz: from 1800 to 1830, being about 130 cases: 53 of these occurred between 1810 and 1820. It is to be observed that serious as is the amount of damage shewn by these cases, it must still be considered as forming a minor portion of that which has occurred in H.M. service within the period above-mentioned; the list must be taken, therefore, merely as a limited collection of cases which have come to the author's knowledge, through the kindness of a few private friends; evidently proving how serious the whole amount of damage would necessarily appear, could it be collected through the intervention of official and influential investigation; a channel of enquiry to which the author in vain sought access.

The history of these cases is still, however, quite sufficient to shew the fallacy of an opinion, which some endeavour to maintain, viz: that the damage occurring to our shipping from lightning, is comparatively small, and not, upon the whole, deserving any great attention. This argument against the employment of an efficient system of defence against lightning in our navy, is very beside the question: it is not admitted, for example, in the case of other articles of a ship's equipment, calculated to save life or property: the use of the life-buoy, for instance, has never been objected to on the ground that the number of cases in which it has been required, are upon the whole, comparatively few; *it may be*, that for the last year no vessel has had occasion to use the life-buoy, or even her sheet anchor; but we are yet to learn that it would be prudent on this account to discontinue the use of these two great protectors of life and property.

In collecting the cases given in this paper, it was almost impossible to avoid some minor errors respecting the dates, &c., but as the facts directly connected with the damage were well authenticated, these errors can have no material influence on the general enquiry; the author, moreover, in examining these cases, has reasoned only upon such, the particulars of which were fully ascertained.

CASES OF DAMAGE BY LIGHTNING

IN THE BRITISH NAVY.

(The cases taken from the Official Log Books are marked thus *.)

No.	Ship's Name.	Guns.	Remarks.
1	AJAX	74	In 1813, main-mast disabled.
2	ARETHUSA	36	In 1816, main-mast shivered.
3	ARROW	10	In 1810, main-mast disabled.
4	ACTIVE	36	In Gibraltar Bay, 1802, one man killed—main-mast damaged—main-top-mast and top-gallant mast destroyed.
5	APOLLO	44	In 1811, particulars not fully ascertained.
6	AREPHUSA	44	Sierra Leone, 1811, one man wounded—main-mast damaged—main-top-mast shivered.
7	AID	10	On survey, Mediterranean, August, 1819, shivered main-top-mast.
8	ACHATES	18	In 1812, damaged main-mast.
9	ASSISTANCE	10	1790, two men wounded; further particulars unknown.
10	AGINCOURT	74	1798, Mediterranean, many men wounded severely.
11	ARMADA	74	1811, Basque Roads, fore-mast set on fire—men struck down on the decks.
12	ALBION	74	Sheer Hulk, Portsmouth, 1821.
13	ALBION	74	Jamaica, 1799, shivered main-mast—destroyed main-top-mast and top-gallant-mast—set main-sail on fire.
14	ATHOL	28	Coast of Africa, 1831, shivered fore-top-gallant-mast: top-mast, &c., saved by chain topsail tye and sheets.
15	ARIADNE	28	June, 1805, Bermuda, split fore-top-mast and top-gallant-mast—several men severely hurt.
16	ALBACORE	20	August, 1798, Jamaica. Shivered main-mast—destroyed main-top and top-gallant-masts—damaged the main yard,*
17	ALEXANDER	74	Port Mahon, 1801, lost main-top-mast.
18	BELLEROPHON ..	74	August, 1807, one of the Hon. M. D. Courcy's Squadron, off Rochfort, lost main-top-gallant-mast—main-top-mast shivered in pieces—main mast damaged—mizen-top mast shivered in pieces—mizen-mast damaged severely—perforated quarter-deck—started a butt end in the ship's side—a rider underneath the deck split—one man killed—eight men wounded.*

No.	Ship's Name.	Guns.	Remarks.
19	BELLE POULE ..	38	January, 1809, in the Adriatic, on the blockade of Corfu.
20	BARFLEUR	98	1812, off Toulon, fore-top-mast shivered—fore-mast damaged—light-room windows of fore magazine shattered.
21	BADGER	18	August, 1822, at Chatham, mast damaged, in ordinary.
22	BLOODHOUND ...	10	Coast of Newfoundland, August, 1812, main-mast shivered, sails rent.*
23	BARHAM	50	Mediterranean, 1836, damage not ascertained.
24	BUZZARD	14	At Minorca, 1812, lost main-top-mast and top-gallant-mast, &c.*
25	BUZZARD	10	Fore-top-mast and top-gallant mast shivered, fore mast wounded.
26	CONQUESTADOR ..	74	1813, particulars not ascertained.
27	CRESSY	74	1812, off Cherbourg, lost main-mast.
28	CHANTICLEER ..	18	1822, October, at Corfu, shivered main-mast from the truck to the deck.
29	CLINKER	14	1829, January, Coast of Africa, lost her main-mast.
30	CHICKEN	14	Fernando Po, 1828, masts damaged—lost main-mast.
31	CAMBRIAN	44	February, 22, 1799, off Plymouth, fore-mast struck—two men killed—twenty wounded—main-top-sail split—fore top-mast damaged slightly.*
32	CAMBRIAN	44	January, 1798, main-mast-head slightly damaged.
33	CLORINDE	44	March, 1813, off Ceylon, main-mast shivered from mast-head to deck—main-top-mast destroyed—two men killed—five wounded seriously—many hurt.*
34	CALEDONIA	120	In Basque Roads, in 1810, fore-mast damaged—fore-top-mast and top-gallant-mast shivered—several men wounded—ship on her return obliged to shift her fore-mast at Spithead.
35	DRAGON	74	Mediterranean, Nov. 1810, main-mast and main-top-mast disabled and sprung—top-gallant-mast carried away—main-top-sail split.
36	DUKE	90	West Indies, 1793, main-top-gallant-mast and yard disappeared—main-mast and top-mast severely damaged—obliged to be cut away. It appears by a communication from Admiral Belford, that the ship was at the time in action under a battery at Martinique.
37	DRUID	32	August, 1829, West Indies, damage unknown.
38	DICTATOR	64	October, 1794, at the time of sailing with convoy from Martinique, main-top-mast and main-mast disabled—ship detained a week—figure-head set on fire.
39	DRYAD	36	Mediterranean, March, 1828, damage not ascertained.
40	DRUID	36	1790, lost fore-top-mast—several men killed.
41	DORIS	36	1808, particulars not ascertained.
42	DESIREE	36	1803, Jamaica, main-mast shivered—main-top-mast destroyed.

No.	Ship's Name.	Guns.	Remarks.
43	DRAGON	74	1801, Summer, one man killed—several wounded—all the men in main-top injured—some severely—further particulars not ascertained.
44	ELEPHANT.....	74	November, 1790, Portsmouth, main-mast shivered and main-top-mast.
45	EOLUS	32	West Indies, 1809, fore-mast damaged severely—top-gallant-mast destroyed.
46	EDEN.....	28	In 1822, particulars not ascertained.
47	ELK	18	In 1816, fore-mast shivered.
48	FISGARD	36	In Gibraltar Mole, particulars not ascertained.
49	FOUDROYANT ..	80	July, 1799, Mediterranean, three men killed; further damage not ascertained.
50	FOX	10	Revenue Cutter, mast damaged from cap downward, <i>except</i> where it was <i>coppered</i> .
51	GLATTON	54	May, 1794, Mediterranean, considerable damage—lost mizen-mast, top and top-gallant masts, beside other damage—(Log of the Lion).*
52	GLOUCESTER....	74	Malta, August, 1830, main-mast and main-top-mast crippled and shivered—ship obliged to refit.
53	GOLIAH	74	August, 1802, fore-mast splintered—top-mast and top-gallant-mast shivered—two men killed—thirteen wounded—all the gear aloft on the fore-mast went overboard.
54	GIBRALTAR	80	September, 1802, at Gibraltar, lost fore-mast—also fore and main-top-masts—three men wounded.
55	GRIFFIN	18	July, 1808, lost main-mast.
56	GALATEA	44	June, 1805, West Indies, lost fore-top-mast and fore-top-gallant mast—several men wounded.
57	GLORY	98	Cape Finisterre, main-top-gallant-mast destroyed—main-top-mast shivered—main-mast damaged—several men in the tops severely hurt. <i>This ship formed one of Sir R. Calder's fleet, and the damage occurred just before meeting the combined fleets of the enemy, so that the ship was already crippled in her main-mast.</i>
58	GIBRALTAR.....	80	In 1801, off Cadiz, main sail set on fire.
59	GLOUCESTER....	74	At Cephalonia, in 1830, lost main-top-mast.
60	GENEREUX	80	Port Mahon, February, 1801, lost fore and main-top-masts—main-mast damaged severely. * * *—This ship formed one of the fleet under Sir. J. B. Warren, which having refitted at Port Mahon, had just proceeded to sea in pursuit of the French squadron under Gantheaume. It is a remarkable and very important fact, that the whole of the British squadron were more or less disabled by lightning: It appears by a letter from Admiral White, then Captain of the flag ship, that the fleet sustained as much damage in spars as would probably have occurred in a general action. The Genereux was so dis-

No.	Ship's Name.	Guns.	Remarks.
60	GENEREUX (<i>cont.</i>)	80	abled that she did not again sail until the peace. The fleet consisted of the Renown, Dragon, Gibraltar, Hector, Genereux, Haerlem, line of battle-ships; the Mercury and Phœnix, frigates.
61	GUERRIERE	36	It appears by <i>James's Naval History</i> , vol. vi. p. 132, that this ship engaged the large American frigate Constitution, with her main-mast in a tottering state from lightning. (<i>James's Naval History.</i>)
62	HYACINTH	18	Indian Ocean, fore and main-top-mast and top-gallant-mast shivered—head of fore-mast rent—struck first on fore-mast. * * * —The lower masts appear to have been saved by the chain top-sail sheets, and by one of Earle's patent pumps, which conducted the electric fluid through the ship's side into the sea.
63	HAERLEM	64	Mediterranean, 1800, disabled in main-mast.
64	HECTOR	64	February, 1801, one of Sir J. B. Warren's squadron; amount of damage not ascertained.
65	HYDRA	36	May, 1808, off Sicily, main-mast shivered from the truck to the deck—ship returned to Malta for refit.*
66	HIBERNIA	120	Off Toulon, 1813, amount of damage not ascertained.
67	HELDER	32	1811, Summer, off Copenhagen—main-mast shook from the truck to the deck, and in great part destroyed—other damage—ship sent home in consequence.
68	HELICON	18	February, 1812, Plymouth, main-mast struck—one man wounded.*
69	HERON	20	March, 1828, South America, fore-top-sail-yard shivered in the slings—fore-mast damaged through centre—part of fore-royal and top gallant-studding-sail burned—top-mast-back-stay and shrouds cut through. * * * —It appears by communication from the Hon. Capt. Grey, then commanding the Heron—that out of five ships composing the Brazilian squadron, for the protection of our trade during the war between Buenos Ayres and the Brazils, the Heron and Thetis frigates were about the same time disabled and under refit, the latter having been struck, and the fore-mast and top-mast shivered, whilst the Heron was lying at Rio without her fore-mast—all this it seems happened at a period when the services of the ships were required for convoys, &c.
70	IMPLACABLE	74	July, 8th, 1810, off the Isle of Wight, main-mast damaged slightly—fore-top-mast and main-top-gallant-masts shivered—fore-top-sail-yard carried away in the slings—eyes of main rigging set on fire—two men hurt.
71	INDEFATIGABLE	44	In 1806, Bay of Biscay, two men wounded severely—further damage not ascertained.
72	IMPERIEUSE	44	East Indies, 1800, particulars not ascertained.

No.	Ship's Name.	Guns.	Remarks.
73	JASON	36	In Gibraltar Mole, damage not ascertained.
74	KENT.....	74	July, 1811, Mediterranean, ship disabled in her main-mast, main-top-mast and top-sail-yard; also mizen-mast, top-mast, and top gallant-mast; one man killed, two wounded—went to Port Mahon to refit.*
75	KENT.....	74	Off Toulon, 1813, { particulars not ascertained. 1802, §
76	KENT.....	74	
77	LA LOIRE.....	38	1809, Cadiz, main-mast, top-mast, and top-gallant-mast shivered, two men killed.
78	LARNE.....	20	February, 1820, two men killed.*
79	LIVELY.....	36	Bay of Naples, 1805, particulars unknown.
80	LYNX.....	6	1835, masts damaged.
81	LYNX.....	6	1836, Prince's Island, slight damage to masts.
82	LONDON.....	98	Lost fore-mast.
83	ST. LAWRENCE..	112	October, 1814, Lake Ontario, main-mast & main-top-gallant-mast destroyed—one man killed—ten wounded.
84	LOWESTOFF....	36	Mediterranean, one of Admiral Hotham's squadron, ship made a wreck—masts and rigging on fire—main-mast cut away—fore-top-mast shivered—main-mast and top-mast shivered—two men killed, several wounded and hurt.*
85	LAVINIA.....	44	Particulars not ascertained.
86	MELVILLE.....	74	Malta, September, 1830, split main-top-mast and top-gallant-mast, and damaged main-mast—ship detained to refit and get a new mast.*
87	MAGNIFICENT...	74	April, 1814, off Ushant, lost main-top-mast and top-gallant-mast, and damaged main-mast.*
88	MOSQUITO.....	10	January, 1830, off Corfu, ship struck in several places, two sails set on fire and cut away.*
89	MADAGASCAR....	50	January, 1830, Corfu, main-mast-head set on fire; main-mast and mizen-top-masts severely damaged—ship detained under refit.*
90	MILFORD.....	74	January, 1814, Plymouth, Ordinary, jury-mast damaged.
91	MEDINA.....	20	1830, at Wydah, particulars not ascertained.
92	MONMOUTH.....	74	At Naples, in 1802, particulars not ascertained.
93	MINERVA.....	36	Coast of Malabar, 1791, one man killed—further damage not ascertained.
94	MINERVA.....	36	In 1812, fore-mast disabled.
95	MERCURY.....	32	One of the look-out frigates of Sir J. B. Warren's squadron, Feb. 1801, Mediterranean—main-mast damaged—two men killed.
96	NEREUS.....	36	March, 1814, Rio de la Plata—main-mast disabled—main-top-mast shivered in splinters.
97	NIEMEN.....	36	Spring of 1814, Halifax, lost main-mast.
98	NORGE.....	74	June, 1815, Port Royal, splintered main-top-mast and top-gallant-mast—damaged mizen-top-mast and top-gallant-mast which fell down on deck—four men hurt.

No.	Ship's Name.	Guns.	Remarks.
99	OCEAN	98	February, 1829, at Smyrna, main-top-mast damaged.
100	OCEAN	98	Summer of 1813, in the Rhone, main-top-mast split in pieces, main-mast damaged—ship obliged to go to Port Mahon to have a new mast.
101	ORLANDO	36	In 1815, at Smyrna, main-mast disabled—main-top-mast, and top-gallant-masts destroyed—several men hurt—ship obliged to go to Malta to refit.
102	PIQUE	38	In 1804, Jamaica, damaged considerably—particulars not ascertained.
103	PALMA	48	October, 1814, Carthage, fore-top-mast and top-gallant-masts shivered—grazed the fore-mast—one of the main-deck beams splintered, one man killed—six men hurt severely—many slightly hurt.*
104	PEGASUS	32	1787, particulars not ascertained.
105	PHÆTON	36	In autumn of 1824, Gibraltar, fore-mast shivered from the truck to the deck, and set on fire together with the small sails in the top, also the top-mast studding sail in the larboard rigging—main-top-gallant-mast also struck—signal halliards burned in cinders—several men struck down, but not seriously hurt. Extract of a letter from Capt. Stuart, commanding the Phæton.*
106	PRIMROSE	18	Sierra Leone, March, 1828, lost main-top-mast.
107	PRIMROSE	18	At sea.
108	POMONE	44	January, 1796, at Plymouth, lost fore-mast—main-top-mast-stay-sail set on fire—ship just refitted.
109	POMONE	44	In 1806, off Ushant.
110	PERSEVERANCE ..	36	In 1790, Bay of Bengal, lost fore-mast.
111	PELICAN	18	December, 1837, coast of Africa.
112	PIEDMONTESE ..	36	North sea.
113	POMPEY	74	West Indies.
114	PRESTON		Sheer-hulk at Woolwich, summer of 1822.
115	PRINCE GEORGE ..		Sheer-hulk, Portsmouth, September, 1826, top-mast totally destroyed.
116	PRINCE WILLIAM ..	74	Sheer-hulk, Portsmouth, November, 1790.—one of the sheers destroyed.
117	PRINCESS ROYAL ..	100	June, West Indies, much damaged.
118	PORT MAHON ...	36	Jamaica, 1805, main-mast—main-top-mast and top-gallant-mast shivered—one man hurt.
119	PHENIX	90	February, 1801, one of Sir J. B. Warren's fleet, particulars not ascertained.
120	QUEEN	90	At Messina, 1815, damaged main-mast—ship obliged to go to Malta.
121	RHADAMANTHUS ..		Steam frigate, March, 1837, at Santander, main-top-mast shivered.*
122	REVOLUTIONAIRE ..	44	In 1816, disabled in main-mast.
123	ROYAL SOVEREIGN ..	120	November, 1813, Hamoaze, Plymouth, damaged fore-mast.

No.	Ship's Name.	Guns.	Remarks.
124	ROYAL SOVEREIGN	120	November, 1809, off Barcelona, main-top-gallant-mast shivered—two men killed.*
125	RUSSEL.....	74	October, 1795, coast of France, shattered main-mast and main-top-mast—mizen-mast, top-mast, and top-gallant-mast, severely damaged—first lieutenant killed—two men killed—several hurt.*
126	REPULSE.....	74	April, 1810, coast of Catalonia, shivered main-top-gallant-mast and main-top-mast—rendered main-mast unserviceable— <i>seven men and a boy killed</i> —three badly wounded, died soon after—ten men more or less hurt—some severely.
127	RUBY.....	64	July, 1810, in the great Belt, main-top-mast and top-gallant-mast demolished—main-mast slightly damaged.
128	RESISTANCE.....	44	1791, Bay of Bengal, fore-mast disabled. * * *—This ship was eventually blown up by lightning in the Straits of Malacca, and nearly all on board perished. Authorities, <i>Naval Chronicles, James and Brenton's Naval History.</i>
129	ROYAL GEORGE..	100	In 1813, off Toulon, particulars not ascertained.
130	ROYAL OAK.....	74	Autumn of 1811, Basque Roads, particulars not ascertained.
131	ROYAL OAK.....	74	Bermuda, 1829, receiving ship, main-mast was set on fire—ship had nearly been burned.
132	RENOWN.....	74	February, 1801, damaged mizen-mast. * * *—This ship was the flag-ship of Sir J. B. Warren's fleet.
133	RACER.....	18	October, 1834, off Carthage, fore-top-mast destroyed and main-top-gallant-mast.
134	SPARTIATE.....	74	In 1827, slight damage.
135	SPARTIATE.....	74	In 1828, slight case.
136	SAPPHO.....	18	November, 1820, in bringing home Lord C. Somerset, just after crossing the line, fore-top-mast and top-gallant-mast shivered—fore-mast disabled— <i>seven men killed, three wounded and died—fourteen wounded or hurt.</i>
137	SAN JOSEF.....	120	In Autumn of 1813, in the Rhone, one of the fleet off Toulon, under Sir E. Pellew, main-top-mast and top-gallant-mast shivered. * * *—Of thirteen sail on the blockade of Toulon, nearly one half were severely damaged by lightning at the same time.
138	SWIFTSURE.....	74	In 1806, had her fore-top-sail set on fire.
139	SCORPION.....	18	In 1806, main-mast unserviceable.
140	SABRINA.....	18	In 1811, damaged main-mast.
141	SULTAN.....	74	Off Mahon, February, 1808, jib-boom shivered—bowsprit damaged—seven men killed—three severely injured.*
142	SULTAN.....	74	September, 1812, Island of Tavolaro, main-mast, main-top-mast, and top-gallant-masts split—top-gallant-yard and sail shivered in pieces—detained at Malta under reef.*
143	SOUTHAMPTON..	52	November, 1832, in the Downs, one of a fleet waiting to sail on an important service—damaged mizen-mast—ten beams injured—the electric fluid penetrated to the after magazine.*

No.	Ship's Name.	Guns.	Remarks.
144	SQUIRREL	28	August, 1805, struck twice on the Coast of Africa; the lightning broke to pieces two main-top-masts, two royal masts, and two top-gallant-masts. The main-mast was so splintered that no sail could be carried on it—all the caulking from the fore to the main chains loosened, and one plank stove; the ship made in consequence, eight inches of water an hour.
145	SURINAM	18	October, 1806, main-mast went in three pieces—compasses rendered useless—two men killed—much other damage. * * *—This vessel was employed in reconnoitering the enemy off Belleisle.
146	SUPERB	74	September, 1802, in Gibraltar Bay, slight case.
147	STATELY	64	1801, one of Sir J. B. Warren's squadron.
148	SCIPION	74	Off Toulon, in 1813, one of Sir E. Pellew's squadron, main-top-mast shivered in pieces—main-mast damaged—obliged to go to Port Mahon to refit and get a new mast.
149	SUCCESS	36	In 1800, at Malta, main top-gallant-mast and main-top-mast shivered—main-mast damaged.
150	STAUNCH	16	Rio de la Plata, in 1807, fore-top-mast and top-gallant-mast shivered—bunt of top-sail set on fire.
151	SHEERS		In Halifax Dock Yard, 1812, much damage.
152	TONNANT	80	Winter of 1804, Bay of Biscay, main-mast damaged—one man killed, ten wounded.
153	TONNANT	80	February, 1812, Cawsand Bay, Plymouth, fore and main-mast, also main-top-mast and fore-royal-mast*—obliged to go into Hamoaze and shift her masts.
154	TRUSTY	50	October, 1801, Malta, lost main-mast and other damage.
155	THAMES	32	In 1808, particulars not ascertained.
156	LE TIGRE	80	November, 1809, lost main-mast and main-top-gallant-mast.
157	THISBE	32	In January, 1786, masts shivered—sails and rigging on fire—obliged to cut away the main-mast—ship nearly dismasted—ship's cutter stove.*
158	TAMAR	26	July, 1825, River Hooghly, East Indies, main-mast shivered from truck to deck, and rendered useless.
159	TOPAZE	36	West Indies, July, 1802, mizen-mast shivered from the truck downward—one man killed—one wounded, who died soon after—three hurt.
160	TRIUMPH	74	In 1803, Mediterranean, mat on the main-yard set on fire—two men knocked overboard.
161	THETIS	44	April, 1828, Rio de la Plata, one of the Brazilian squadron employed in the protection of our trade, fore-mast shivered and fore-top-mast.
162	TRINCOMALE	20	East Indies, 1797, particulars not ascertained.
163	TALAVERA	74	Archipelago, December, 1834, particulars not ascertained.
164	TAMAR	36	In 1822, Jamaica, main-top-mast destroyed—main-mast-head shivered.
165	TALBOT	28	January, 1834, at sea, lost main-top-mast.

No.	Ship's Name.	Guns.	Remarks.
166	THESEUS	74	Autumn of 1803, St. Domingo, fore-royal-mast, top-gallant-mast, & top-mast shivered—fore-mast damaged—one man killed close by the fore magazine. * * — This ship was employed in blockading the port of Cape Francoise; she was obliged to leave her station, and proceed to Port Royal to refit—the panic in the ship on this occasion was frightful, the people rushing up the hatchways under an impression the ship was sinking and the magazine on fire, were with difficulty prevented from jumping overboard or taking to the boats.
167	UNION	98	Off Toulon, in 1813, one of the squadron under Sir E. Pellew.
168	VILLE DE PARIS.	120	Off Toulon, in 1813.
169	LA VIRGINIE	44	In September, 1799, Madras Roads, main-top-mast and top-gallant-mast shattered in pieces—main-mast sprung—main-topsail-yard damaged, and the top-sail split.*
170	VALIANT	74	Off Boston, in 1813, main-top-mast shivered in pieces—main-mast head damaged—ship obliged to proceed to Halifax in order to refit, and get a new mast.
171	VANGUARD	74	Mediterranean.
172	WARRIOR	74	Autumn of 1810, Messina.
173	WINDSORCASTLE	98	Autumn of 1794, fore-yard on fire—two men wounded severely.
174	WASP	18	January, 1814, main-top-mast shivered and lost overboard—main-mast so much damaged as to be unserviceable; two men killed.*

GENERAL RESULTS.

From about one hundred cases in the above list, the particulars of which have been ascertained, it appears that about one half the ships struck by lightning, are struck on the main-mast; one quarter on the fore-mast; one-twentieth on the mizen-mast, and not above one in a hundred on the bowsprit.

About one ship in six is set on fire in some part of the masts, sails, or rigging.

In one half the cases, some of the crew are either killed or wounded, or both; the numbers are 62 killed, 114 wounded; this is exclusive of one case in which nearly all the crew perished; and of twelve cases in which the numbers killed or wounded have been set down as several or many. In these 100 cases there were damaged or destroyed 93 lower masts, principally line of battle ships and frigates, 83 top-masts, 60 top-gallant masts.

In one-tenth of these cases, the services of the ships were urgently demanded.

If such a mass of damage has occurred in the navy by lightning upon 100 cases only, it is clear that the loss to the nation in men, in money, and in services of ships, upon the whole number, could they be fairly examined, must necessarily have been very considerable; since we have to take into the account, not merely the property destroyed, but the expense incurred by the detention and refit of the different ships.

Now a line of battle ship costs the country, upon an average, £100 a day, leaving out of the question the loss of men, and the services of the ships.

SECTION B.

INTRODUCTORY.

THIS section of the appendix contains such evidence of the practical value of the fixed conductors, as is obtainable either from actual experience, or from the opinions of persons entitled to our confidence.

The evidence from experience not only proves the great utility of the system, but it also shews most clearly that it is in every respect unobjectionable. It should be remembered here, that it is a great property of the lightning rod, efficiently applied, to disarm as it were, or parry, dense strokes of lightning, so as to avoid, in a great variety of instances, the ordinary concentrated explosion: in the language of Sir H. Davy, "the thunder-cloud is disarmed of its terrors." It would, therefore, not be reasoning logically, or according to the evidence of which the case admits, to say that such evidence has only a negative value. It should be also further remembered, that we are not seeking here to establish any new principle in science, but rather to act efficiently upon principles already admitted. The question applies, in fact, to a given method of applying lightning conductors on ship-board: what we require to prove, therefore, is the consistency of the method with the nature of a ship's masts, and with the variable circumstances in which the general fabric, in all its casualties, may become placed. With respect to the conductors themselves, they evidently stand on common grounds with those already employed in other departments of the public service, e.g.—powder magazines and other buildings: to admit the value of this method of defence in the latter, and deny it in the former case, would evidently amount to an absurdity.

The testimony derivable from the consideration given to the question by others—inasmuch as it is the result of the cool and deliberate judgment of men qualified to pronounce on its merits—must be considered valuable and highly worthy of attention: it is, in fact, still a species of evidence from experience, since it is from this source the judgment has proceeded.

DOCUMENTS.

REPORT ON THE LIGHTNING CONDUCTORS OF H.M.S. BEAGLE. 1831-6.

“Previous to sailing from England in 1831, the Beagle was fitted with the permanent lightning conductors invented by Mr. Wm. Snow Harris, F.R.S.”

“During the five years occupied in her voyage she was frequently exposed to lightning, but never received the slightest damage, although supposed to have been struck on at least two occasions.”

“At each of these times, at the instant of a vivid flash of lightning, accompanied by a crashing peal of thunder, a hissing sound was heard distinctly on the masts, and a strange, though very slightly tremulous, motion in the ship herself, indicated that something unusual had happened.”

“No objection which appeared to me valid, was ever raised against them; and were I allowed to choose between having masts so fitted and the contrary, I should decide in favour of those with Mr. Harris’s conductors. Even in such small spars as the Beagle’s royal masts and flying jib-boom, the plates of copper held their places firmly, and increased rather than diminished their strength.”

“The Beagle’s masts, so fitted, answered well during the five years’ voyage above-mentioned, and are now fit to go on another equally long voyage.”

“(Signed) ROBERT FITZ ROY,
Late Captain of H.M.S. Beagle.”

(b) *Copy of a letter from Capt. Turner, late of H. M. ship Dryad.*

“H.M. Ship Dryad, Sierra Leone, February 13th, 1831.”

“My dear Sir,

I write to inform you that we have had a trial of your conductors, and most excellent things they are. During our last cruise we had a great deal of lightning, but in one afternoon in particular, we had a tornado, which is always attended with a great deal of thunder and lightning: whilst standing on the quarter deck during one of the flashes, I distinctly saw the lightning run down the conductor on the foremast, and the officer of the fore-castle came and told me he heard a

whizzing noise resembling water boiling. All the men that were there heard it also : a short time afterwards several of the officers were standing abaft, and saw it during another flash go down the mizen mast with the same whizzing noise. It may be necessary to tell you that lightning on this coast appears to remain longer in the air than any other place I was ever at. It has given us all great confidence in the conductors ; no doubt after another trial, the commodore will report the great advantage of having them to the Admiralty. I am glad to hear you are fitting some ships at Portsmouth ; I hope to see every ship in the navy fitted with them : carrying sail has no effect at all upon them, for we carry a great deal of sail at times. With kind regards."

"I am, &c., &c.,
Wm. Turner."

REMARKS.

The phenomena described have a remarkable agreement with those mentioned in Capt. Fitzroy's report—e.g : the hissing sound, &c. The ship was evidently struck by lightning in the common way, but without the ordinary ill consequences. The electric agency seems to have fallen so powerfully on the masts, that it produced about them a luminous atmosphere ; a phenomenon not uncommon when large quantities of electricity traverse conducting bodies, in a heated or rare state of the air, such as that usually found on the coast of Africa. Capt. Turner tells a very simple and a very plain story : we may place complete belief in his statement, backed as it is by well known results in electricity, and by the concurring testimony of others. It is however but fair to state, that Commodore Hayes not being on deck at the time, did not witness these effects, and hence, made no official report on them. The author used all his endeavours to procure an enquiry before the ship was paid off, and the officers and crew dispersed, but without effect. These circumstances, so important to science, were allowed to sink gradually into obscurity.

(c) *Copy of a letter from Capt. the hon. W. Wellesley, late of H. M. ship, Sapphire.*

"17, South-Audley-street, May 30th, 1837."

"Dear Mr. Harris,

As I understand that many persons object to your lightning conductors, as being dangerous, inasmuch as they consider them liable to attract the lightning to the ship, I am anxious to state to you, that whilst I commanded the *Sapphire*, in the West Indies, in which ship they were fitted, we were in several instances enveloped

by lightning ; more particularly on one occasion, in the Gulf of Mexico, when the lightning was extremely vivid and near. Yet the ship received no damage, nor was struck, so far as I know ; but I am of opinion, that with these conductors, it would not, under certain circumstances, be possible to discover whether the ship had been struck or not."

" Believe me, &c., &c.,

W. Wellesley."

Remark. The author was informed by Capt. Wellesley, that the lightning was so vivid and forcible, that it was not deemed safe to hoist out the boats.

(d) *Copy of a letter from Capt. the hon. F. Grey, late of H.M. ship Acteon.*

" War Office, March 3rd, 1838."

" My dear Sir,

You asked me my opinion of your conductors, and I have great pleasure in stating to you, that upon my application they were fitted in the Acteon, in the spring of 1831. From that time till September, 1834, I commanded her in the Mediterranean ; and in that period we were several times exposed to very severe thunder storms, and in no case had we ever a ropeyarn cut. I cannot inform you what report was made upon her spars when she was paid off, but nothing ever went wrong about them, nor did any accident ever occur to them, except in one instance, in sending a top-gallant-mast on deck, when one of the copper plates started, but was renailed in a few minutes. In fact, in my opinion, they are so desirable, that if I were appointed to a ship, I should immediately apply to have them fitted."

Capt. Grey then relates the circumstances already given in page 11, sec. 13, and concludes thus : " I trust what I have said will fully shew how highly I esteem the benefit which the adoption of your conductors generally would prove."

" Believe me, &c., &c.,

Fred. W. Grey."

(e) The author was informed by Capt. Fitzroy, that he had fallen in with the Druid in the course of the late voyage of the Beagle ; and learned from the officers, that the ship had been exposed to severe thunder and lightning, and that they considered the masts to have derived protection from the conductors.

(f) The Caledonia, of 120 guns, has been frequently exposed to lightning ; and was in Plymouth Sound on the 21st. of May, 1831, at the time of very heavy thunder and lightning, whilst under sail ; this

was witnessed by the author and many other persons. The crash of the thunder was frequent, and the electric discharge frequently struck down upon the sea near the ship: no damage however occurred; a circumstance which completely sets aside any objection to the use of the conductors, as tending to draw discharges of lightning upon the ship, as some have erroneously imagined.

(g) *Copy of a letter from Sir E. Lyons, formerly commandiuy H.M. ship Blonde.*

“Malta, September 24th, 1830.”

“My dear Harris,

I congratulate you and the service (indeed, I may say, the naval world) on the adoption of your new conductors. We have had an instance in this port very lately, of two line of battle ships (Gloucester and Melville) perfectly ready for sea, and just on the point of sailing to join the admiral, being struck by lightning, and both ships in consequence detained in port for some time; the Gloucester being obliged to have her main mast taken out. I am perfectly convinced that if those ships had been fitted with your conductors, they would have escaped with impunity. I congratulate you on having at last convinced the world of the efficacy of your very beneficial plan, for averting the most awful and destructive visitation to which we sailors are exposed.”

“Pray believe me, &c., &c.,

Edmund Lyons.”

Remark. Independently of the expense incurred by this; the time, detention, &c., it bears materially on the consideration of the possible result to our naval power. Suppose the two line of battle ships mentioned had been required on any critical occasion, in time of war, as for example, previously to the battle of the Nile, and that the fleet had lost in this way the services of two sail of the line, might not the consequence have been serious to the country?

(h) *Copy of a letter from Capt. Briggs.*

“Sir,

I received your letter, and in reply beg to inform you that the accident to which you allude, happened on board the *Clorinde*, when that ship was off Friar's-head, on the east coast of Ceylon, in March or April, 1813. The weather was moderate: about three in the afternoon we observed a dark cloud approaching the ship from to windward; this induced me to clue up the top-sails: about an hour after, the frigate

was struck by lightning : the cloud we had observed was charged with electric matter, which burst on the ship : the main-mast was shivered in pieces—only a wreck remained,—three men were killed, and many much hurt.

From the experiments I witnessed at Plymouth, relating to the application of your metallic conductors to the masts of ships, I am convinced the *Clorinde* would not have sustained any injury if your conductors had been fixed on her masts."

"I am, Sir, &c.

THOMAS BRIGGS."

(i) Copy of a communication from Admiral Sir T. Hardy, lately one of the Lords Commissioners of the Admiralty, to Admiral Sir T. B. Martin.

"Admiralty, February 19th, 1833."

"My dear Sir Byam,

You cannot have a higher opinion of Mr. Harris's lightning conductors than I have ; and I am always ready to give him my support. The expense, I believe, is the only cause of their not being generally adopted."

"I remain, &c., &c."

Remark. It would appear by this communication, that the Lords of the Admiralty were at this time satisfied of the utility of the conductors ; surely then, the consideration of a fallacious economy should never have outweighed that of the lives of our seamen, and the welfare of our fleets.

(k) Copy of a note from Lord Minto, in reply to the author's offer to repeat some experiments, which his Lordship did him the honor to witness.

"Admiralty, May 22nd, 1837."

"Sir,

I beg you to accept of my best thanks, although I regret to find, that engagements will not allow me to take advantage of your obliging offer ; indeed your exhibition on Friday was so satisfactory as to leave little unexplained."

"I have the honor to be, Sir,

Yours faithfully,

Minto."

Remark. The same reasoning applies as in the former case ; if the validity of the measure be admitted, in all its details, are we not called upon by the highest considerations, to give it at least a fair encouragement ?

(l) *Report of the Royal Society, and approval of Dr. Wollaston.*

A committee of the Royal Society having been called upon to report on Mr. Harris's proposals, gave their full approval of his idea of a fixed, continuous conductor. The committee being informed that an inflexible metallic rod was not applicable to the conditions of a ship's mast, they assented to the form proposed by Mr. Harris; this report was signed by Wollaston, Davy, and Young. The learned Dr. Wollaston, one of the committee, in a letter to Sir T. B. Martin, then comptroller of the navy, expressed himself in the strongest way favorable to Mr. Harris's views, as may be seen by the following memorial, sent by the comptroller of the navy to the Admiralty, when H.R. Highness the Duke of Clarence filled the office of Lord High Admiral.

(m) "Whilst at Plymouth, H.R. Highness was pleased to attend some experiments, to prove the efficacy of a mode of protecting ships from lightning, suggested by Mr. William Snow Harris."

"The object of the conductors in question, is to remedy the evils complained of in the common conductors, on account of their being moveable, and seldom applied to their intended purpose. Mr. Harris's conductor consists of slips of copper, of a competent size, applied up and down the masts, and leading in a perfectly continuous line from the spindle at the mast-head into the water, through copper bolts in the keelson; and the application is so managed by Mr. Harris's ingenious contrivance, that the conductor adapts itself to every circumstance in which the mast is usually placed; so that whether the masts are all up, or whether the top-masts are struck, or only the lower masts in, the conductor remains in its perfectly efficient state night and day, under every circumstance."

"The subject was brought forward in 1823, and was then, and has since been, submitted to much investigation; yet still, notwithstanding the approval of many scientific men, and particularly of Dr. Wollaston, the plan has not yet been generally adopted."

"Dr. Wollaston, in a letter to me in April, 1823, says, '*in reply to the enquiry, whether I see any danger, insecurity, or liability to objection, in the method proposed by Mr. Harris, of carrying off lightning from ships by fixed conductors, I certainly ought most unequivocally, as far as my opinion may go, to express general approbation of his proposal.*'"

"Mr. Harris appears to me to be well acquainted with the subject, and fairly to estimate the powers of the element with which we have to contend, and the means of directing it, with as little injury as may be to surrounding objects."

"After such an opinion from a person so eminent in the pursuits of science as Dr. Wollaston, the subject seems about to resolve itself into the question—whether any conductor whatever is good, and if so, whether

one embracing so many conveniences and obviating so many objections as Mr. Harris's, ought not to be introduced into the navy in preference to those now in use."

"(Signed) T. B. Martin."

(n) Sir David Brewster, in the new edition of the *Encyclopædia Britannica*, has treated of conductors of lightning for ships, and having described those proposed by the author, concludes by observing, "it is a remarkable circumstance, that though Mr. Harris has proved the excellence of his invention by its practical application to some British frigates, yet the Admiralty have not felt it their duty to introduce it into the navy. A line-of-battle ship is valued at about £120,000, and yet it is not thought advisable to expend £100 in defending from the most irresistible of all enemies this vast and valuable machine, and in protecting the lives of the thousand brave men that live within its walls."

Remark. Whilst these pages are printing, it appears by the public journals, that the *Rodney*, of 84 guns, has been set on fire by lightning, and two of her crew killed, &c., &c. The flames were with difficulty extinguished, after a quarter of an hour's arduous exertion. This fact it will be perceived is strikingly illustrative of what Sir. D. Brewster has stated; and is also in complete accordance with the view taken of the question in sec A. Supposing this had occurred in the middle of the Atlantic, or some other vast sea, and under more disadvantageous circumstances, with a ship in a less excellent state of discipline than the *Rodney*,— is it not clear that the vessel might have been blown up, or otherwise lost and never more heard of? The *Resistance* it is pretty well known perished in this way.

(o) DOCUMENTS RELATING TO EXPENSE.

The following are extracts from a report by a gentleman who was sent from his majesty's dockyard at Chatham, by order of the commissioners of the navy, to estimate and inspect the work; and who, being a naval engineer, and otherwise a person of great intelligence, was considered by them equal to the task.

"His Majesty's Dockyard, Chatham, July 9, 1834."

"Sir,—In obedience to instructions received from the principal officers of this yard, in conformity with your official communication of the 1st

instant, I herewith enclose a statement (in a condensed form) of what would be the expense, in labour and materials, of applying Mr. Harris's lightning conductors to each class of ships, supposing them fitted at the most eligible time. I have likewise ventured to append a few cursory remarks, which seemed necessary in order to afford a criterion of what may probably be the *ultimate expense* to the public, in the event of the plan being generally adopted in the service. With this view, I beg further to transmit schemes of prices for labour, for different artificers employed on the work, upon which it should be added the accompanying estimate has been made."

"I have the honour to be, &c. &c.,

W. M. RICE."

"To G. J. Smith, Esq., Secretary of H. M. Navy, &c."

Mr. Rice then proceeds to give a complete table of particulars in the fitting each part of a ship, according to the plan above mentioned, the whole of which it is not necessary to detail here. It will be sufficient to state the general results as they appear in the last columns of his table.

TABLE 5.

Class of Ships.	Total of Masts and Hull.					
	Labour, &c.			Reconvertible Copper Materials.		
	£.	s.	d.	£.	s.	d.
120 guns	60	18	0	305	12	2
84 ..	56	18	0	292	19	11
74 ..	54	17	0	263	2	3
50 ..	50	16	0	235	17	3
46 ..	45	15	0	190	16	4
28 ..	38	14	0	123	13	3
18 ..	29	12	6	89	14	8
10 ..	24	10	0	77	16	9

83. Upon this report Mr. Rice offers the following remarks:—

"This estimate is grounded on the supposition that Mr. Harris's plan be applied to ships at the most eligible time, viz: during the progress of building or repairing, when the essential or original fastenings of the hull may be made to subserve as conductors: much delay will be thus prevented, and many contingent expenses saved."

"As the prompt execution of work much depends upon the facilities afforded to the workmen, I beg without further recapitulation, to refer particularly to the arrangements proposed in the letters and drawings which I had the honour, on a former occasion, to submit for the consideration of the commissioners of his majesty's navy; humbly concei-

ving that they will greatly assist the desirable object contemplated by Mr. Harris, inasmuch, as by adopting them, the practical process will be greatly simplified, and the general introduction of the plan much facilitated."

"It may be proper to make a few observations on the subject of expense. Referring to the accompanying condensed statement, the last column *but one* denotes the *money absolutely sunk* upon the first ship of each class fitted with lightning conductors, and the *last* column, the outlay upon *reconvertible materials*, which must be viewed as other articles of a ship's furniture for the protection of lives and property, such as *life-buoys, &c. &c.*, with due allowance for wear and tear. In taking therefore, a prospective view of the expense, very considerable abatement will be made upon the first cost by return of copper into store, which it is presumed will have suffered very little deterioration after many years' service; moreover, the straps over the heads and heels of masts, nuts, and screws, vanes, and vane-spindles, and the branch conductors under the beams, when removed from any ship, may all be placed in store, to be again replaced in other ships of the same class; the plates taken out of masts may probably be made serviceable by redressing, or, at most, will only suffer a loss at the rate of one penny per pound for remanufacturing: the plates removed from ships' hulls may certainly serve for many ships successively. Hence should the plan be generally adopted, the amount of labour will be much reduced by the appropriation of serviceable articles to several ships, so that the loss alone upon the material *must not be charged* again upon a second or third ship."

"The absolute expense to the public is really the aggregate of the amount of labour, &c., as money sunk, with interest, together with the interest upon the first cost for copper for a given time. It would be difficult to assign any scale of per centage for the protection of ships by lightning conductors; but, in order to form some notion, within certain limitations, let the value of a first rate, when fully equipped, be assumed in round numbers as worth £110,000, the value of property simply considered, neglecting the consideration of lives, and the dangers and disasters arising from a disabled ship, and taking the average of five years' run only upon the principal and interest, the annual premium would be less than £30, making the per centage under *six pence halfpenny*."

"If we extend the term of years, the aliquot part of the money sunk will of course be less, and therefore the per centage will be reduced in like proportion; but, if this view of the expense be carried forward to a second, or a third ship, the *money sunk* will be very considerably less, on account of the diminution of labour, &c., whilst the term of years

is still further increased; and *therefore the premium or per centage, would be ultimately trifling.*"

“(Signed) W. M. RICE.”

“Chatham Yard, July 9th, 1831.”

The above report seems sufficiently explicit, and appears to include a very fair estimate of the expense, taken without reference to other circumstances; but we must not altogether neglect the saving to the country likely to be effected at various times, on the supposition that ships can, by the method above detailed, be effectually secured against damage by lightning: this, as already shewn, (sec A) is of a serious amount.

It is admitted, that the expense attendant on the new conductors when first fitted, was in one or two ships considerable; and that some few cases occurred of a trifling kind in which the copper plates were not well secured, as noticed in Capt. Grey's communication; but all this arose from the work being new, and the process of fitting not completely perfected. Circumstances of this nature always occur in almost every department of the mechanical arts when a new process is at first put in force, as is sufficiently evident in the case of the steam engine and other important machines. The amount of expense as now incurred is extremely reduced, and the system of fitting made sure and easy.

SECTION C.

Copy of correspondence with Rear Admiral Warren, Admiral superintendent of the Plymouth Dock Yard.

“Plymouth, 13th March, 1838”

“Sir,

As several of her majesty's ships fitted with my new lightning conductors have been paid off at Plymouth, and their spars returned to the dock yard, I should be much obliged by your informing me, whether the conductors still remain in them? Whether any having the conductors have been re-issued? Whether in the case of their having been removed from any cause, they have been refitted in another ship or have been duly set aside for that purpose? as also, whether any spars with the conductors in them, are yet remaining in store.”

“I am, Sir,

Your very obedient servant,

W. SNOW HARRIS.”

“Plymouth Yard, 16th March, 1838.”

“Sir,

As requested by your letter of the 13th instant, I beg to enclose to you a report of the particulars therein required, respecting the spars in store, fitted with lightning conductors, on the plan suggested by you.”

“I am, &c., &c.”

Signed by the Admiral Superintendent.

Copy of the report to the Master Shipwright.

“Plymouth Dock Yard, 15th March, 1838.”

“Sir,

In reference to the questions contained in Mr. Harris's letter of the 13th instant, I beg to state:

1st. That the conductors in the spars of ships paid off at this port have been removed, with the exception of five top-gallant masts returned from the *Forte*, which are now in store, the conductors remaining in them.”

“2d. No spars have been re-issued with the conductors remaining fixed.”

“3d. The conductors which have been removed, from whatever cause, have not been refitted to other ships, but returned into store in common with other old copper.”

“Mr. Harris’s fourth question appears to be answered in the first paragraph of this memento.”

“(Signed) J. F. Hawkes.
J. Shaw.”

“To the Master Shipwright.”

In consequence of this correspondence, I addressed the following letter to Sir J. Barrow, who had previously favored me with an interview on the subject.

“Plymouth, 19th March, 1838.”

“My dear Sir,

I wrote to admiral Warren soon after my return. You will see by the copy of the correspondence herewith transmitted, that the new lightning conductors have been, with a few very trifling exceptions, all torn out of the masts and thrown by in a somewhat contemptuous way as old copper: thus, the plates which might have been very well replaced in other ships, have not even been taken care of. The correspondence with Admiral Warren is very brief, and will not cost you five minutes attention.”

“After the explanation you were so good as to favor me with respecting the conductors, I cannot but believe you would wish to have me fairly dealt by in this matter; and I should hope that the Board would not, on a review of the facts, treat me ungenerously. Let us then see in *as few words as possible* how the matter stands in relation to the Admiralty, the country, and myself.”

“1st. It is an admitted fact, that ships may be *burned and destroyed by lightning*; the logs of the navy shew that this is by no means improbable, and that some missing ships may have perished from this cause. They exhibit a loss of life, of damage, and loss of services of ships at critical periods, not generally appreciated: well then, this subject has been deemed of sufficient consequence to engage the attention of scientific persons for more than half a century, and some steps have been taken to palliate the effects of lightning on ship board. The methods proposed have been *inadequate in some way*, for the damage has continued up to the present time; notwithstanding that buildings on land have been protected from this source of danger.”

“2nd. In the year 1820 I investigated *practically* this question, and shewed how the fixed continuous conductors of Franklin might be rendered available on ship board, and how by a perfect system of conduction throughout the hull, all the protection which could possibly be obtained from admitted scientific principles, would be arrived at.”

“3rd. My proposals were eventually carried into effect in eleven ships of the navy, and the result has been as perfect as could be hoped for. The written testimonies of officers in command of the ships,

prove that they have been exposed to heavy thunder storms; that they have been actually struck by the electric fluid, without in any case receiving the slightest damage: thus, not only shewing that the conductors are *unobjectionable*, but actually useful."

"4th. The conductors not only stand upon this, but they are supported by the avowed opinions of some of the most talented men in science the country has to boast of: almost every naval officer, to whom the conductors are known is desirous to have them, and many have applied for that purpose; and this feeling prevails even with the sailors who were at sea in the ships fitted with them, as, for instance, in the *Beagle* and *Dryad*."

"5th. In the face of all this how does the matter actually stand at this present instant? why thus, the ships in which the conductors were fitted, have been nearly *all paid off*, the plates *have been commonly torn out of the masts, and thrown by as old copper*, and no notice taken of it. A great national experiment has been *abandoned*, and the results lost to the country, without any assignable reason, without enquiry. An experiment of great consequence to our commercial and naval prosperity, and one which has occupied the attention of the scientific part of Europe for upwards of 70 years."

"Can the affair possibly rest here; I am sure this could not be the serious intention of the Board; nevertheless, such is the actual state of the question in relation to the admiralty and the country.

"6th. In respect of myself, I must necessarily feel the circumstances above detailed to be very severe, and uncalled for by any thing on my part: it is always difficult to speak of one's self; there are however some cases in which we are called upon to do so; this appears to be one of them; and if it be done with becoming diffidence, I trust you will excuse it."

"It is well known, that so far as my ability has enabled me, I have for many years cultivated with great zeal, experimental science; and have not spared *time, toil, or money*, in doing so, as I believe my papers in the 'Philosophical Transactions' fully shew; indeed, the Royal Society marked their sense of my contributions to the pages of the 'Transactions', by awarding me their Copley medal in 1835. Many of my researches in electricity and magnetism have been of practical advantage to the navy; I may claim, therefore, at the hands of the Board some little attention."

"Now, in perfecting the application of conductors in ships, I have incurred, not only a very serious responsibility, but a very heavy expense. You cannot but believe, that if any damage had happened, either to the ships fitted with the conductors, or even to the buildings at the Victualing office at Plymouth, (which, I should remark, were protected from lightning under my direction,) I must have been the *person* held respon-

sible with the public. Is it right that one who successfully labors to promote the national science, and whose services have been advantageously used for the general good of the navy, should be passed by with coldness and neglect? Here are these conductors, notwithstanding the many documents and facts conclusive of their value, thrown unceremoniously aside as old copper, and no notice taken of it: surely, without any claim I may have to the consideration of the Board on the ground of general science, this it must be admitted has the appearance of dealing somewhat unjustly by me. I cannot but believe, that in stating thus freely all I have to say to you, I am appealing to one who has himself done much for the literary honor of our country, and who, anxious for the advancement of natural knowledge, must necessarily feel well-disposed to promote an enquiry into such a case. When we consider the resources of this powerful nation, and how much its interest is involved in its naval and commercial prosperity, it surely cannot be on account of a thousand or two pounds that an invention of practical advantage to the navy is laid aside."

"I trust you will be so good as to bring this matter under the consideration of the Board, and will do me the justice to believe, that I desire nothing which may not come fairly and openly before the country, without any kind of reservation whatever."

"I am, dear Sir, &c., &c.,

W. Snow Harris."

Sir John Barrow made a courteous reply to this communication: the matter, however, eventually terminated in nothing more than the fitting of the Acteon, without my knowledge, in the way before explained, sec. 19, page 13.

SECTION D.

Copy of correspondence with the admiralty, on the subject of an extract from a report on the new conductors to the admiralty, from the officers of the Plymouth Dock-yard.

“Admiralty, 12th December, 1837.”

“Sir,

With reference to former correspondence upon the subject of your lightning conductors, I am commanded by my lords commissioners of the admiralty, to transmit to you the accompanying *extract of a report from Plymouth Dock-yard*, relative to the state of the masts of the *Caledonia*, in which the conductors were fitted.”

“I am, &c., &c.,
C. Wood.”

“W. Snow Harris, Esq.”

Extract of a report from the officers of Plymouth Dock-yard, dated 6th December, 1837.

“We beg leave to acquaint you that the conductors have been removed from all the spars returned from the *Caledonia*; that the main-top mast has been converted to a brig’s main-mast; the fore and main-top-gallant masts have been appropriated to jury gear; and that owing to the scores left in the spars by the removal of the conductors, it will be necessary to reduce them before they be re-issued.”

“Plymouth, 16th December, 1837.”

“Sir,

I feel much indebted to the lords commissioners of the admiralty for the extract of the report from the Plymouth Dock-yard, relative to the state of the masts of the *Caledonia*, fitted with my lightning conductors; and hope to be permitted to offer the following remarks on it, which their lordships will, I trust, take into their candid consideration.”

“I find on enquiry, since I was honored with their lordships’ communication, that when the *Caledonia* was dismantled:—

“1st. That her three working top-masts, having been in the ship for more than seven years, were so rubbed in the caps and otherwise worn, that they were not considered fit for further service.”

“2nd. That no kind of defect was discovered arising out of the application of the lightning conductors: that so far as the conductors were concerned, the masts might *have been again used.*”

“We learn, therefore, from these facts, that the conductors remained perfect in the masts, up to the time of the masts being *considered* no longer serviceable, and that since the plates of copper were still good, they might consequently be re-applied to other masts of the same dimensions, without any new expense except in labour.”

“3d. That the three spare topmasts, at sea in the ship for more than seven years, were returned into the store as serviceable top-masts, and might, if they had been permitted to remain in the same state in which they were returned, have been re-issued, either to the Caledonia or to another ship of her class, without the necessity of any alteration whatever. That for some reason not explained, the plates were taken out of the masts, and of course, as a *necessary consequence*, the shallow groove in which they were inserted left exposed.”

“As these spars were never intended to be used without the conductors, any reduction contingent upon their removal was a *matter of choice*; such removal being *quite uncalled for*.”

“I would still, however, respectfully submit to their lordships, that even although the plates should be removed, a reduction of the spar is not absolutely necessary, for if an oak batten was inserted in the groove, in place of the copper, and the whole planed off fair with the round of the mast, I am prepared to shew that the spar would be as serviceable as at first.”

“Admitting, however, that the spar must be reduced, it is still not necessary to do more than fair off the small projection of the groove, (which is after all very little more than a quarter of an inch in depth) the diminution of strength by this is really inconsiderable, and the mast might still be re-issued. The Spartiate’s jib-boom, for example, was re-issued in this way, and I believe answered well.”

“4th. That in the conversion of the top-mast to a brig’s main-mast, the requisite reduction carried all round the spar *was not so great on account of the groove, as was found necessary to bring the spar down to the required size*.”

“Should it be ever requisite to convert a top-mast once fitted with my conductors to any other purpose, the necessary reduction is always much more than is contingent upon the groove for the lightning conductors.”

“Their lordships will I am sure allow, that if after more than seven years, the wood was, on the removal of the copper plates, found so perfect as to admit of the mast being converted into so important a spar as a brig’s main-mast, we have not much to complain of on account of the application of the conductor.”

“I would in conclusion respectfully call their lordships’ attention to the fact, that out of eleven ships fitted with the new conductors, few I believe, now remain in commission, except the Beagle.* That

* That is to say, in which the conductors still remain perfect.

although on being dismantled, their spars, with the conductors in them, remained perfect, and so far as the conductors were concerned, fit to be re-issued, yet, in several instances which have come to my knowledge, the conductors have been taken out of the masts, and the masts used for various purposes. I have no doubt the mast makers can explain why they have been led to do this in many cases, but why they have done so in others does not immediately appear; as no complaint has ever been made of the conductors so far as the masts were concerned, and that without any additional expense to the country the serviceable masts might still have been applied in the same way, and many ships been furnished with this protection from lightning."

"It is well known to their lordships that the *Beagle* was full *five* years on service, and that yet she has again gone to sea with the same spars and conductors in them, on an equally long voyage, with the exception of new top-gallant masts."

"I cannot but respectfully bespeak their lordships' attention to these facts."

"And remain, Sir, &c., &c.,
Wm. Snow Harris."

To Charles Wood Esq., M.P., &c., &c.

SECTION E.

INTRODUCTORY.

This section contains a condensed and brief exposition of the leading points in the general question of the defence of the navy and shipping generally from lightning, according to the method proposed by Mr. Harris. It was originally drawn up and submitted for the consideration of the first lord of the admiralty; soliciting at the same time his lordship's acquiescence in an enquiry, by means of a committee of the house of Commons, into the damage sustained by lightning, as a source of shipwreck, and the possibility of avoiding it by Mr. Harris's method. The object contemplated by this proposal was not any undue interference with the functions of the admiralty, but the full development of a subject affecting the national interest. Hence Mr. Harris was led to hope that it might rather meet the views of the board as being the guardians of the navy, and be carried on under their immediate sanction. Lord Minto however, who had certainly an undoubted right to exercise his free and unbiassed judgment in the matter, did not think the question of sufficient consequence to merit further discussion, and refused to sanction the enquiry asked for.

It is still, however, submitted by Mr. Harris, that the amount of damage sustained by our navy and shipping by lightning, together with the loss of life, &c., &c, as set forth in these papers, (sec. A,) is such as to call for serious attention.

Not longer since than the 28th of December, 1838, the *Rodney* of 92 guns was struck by lightning in the Mediterranean and set on fire; her main-mast shivered, and two of her crew killed. The *Scorpion* brig, and the *Columbine* a short time previously, both suffered in a similar way; these casualties, taking into account the detention and refit of the ships, will not cost the country much less than five or six thousand pounds; leaving the loss of life, and the services of the ships out of the question. According to the estimates of fitting as given in sec. B, this sum would furnish 30 sail of the line, 40 frigates, 20 corvettes, and 47 brigs, with an adequate defence for lightning: taking the copper employed as reconvertible material, and hence so much actual value in the hands of the admiralty. Is it not then very lamentable to find such casualties so frequently occurring, when they may be avoided at a trifling cost? Had the conductors taken out of the *Caledonia's* masts been simply *replaced* in the *Rodney*, and not thrown aside in common with old copper, the lives of the two seamen might have been saved, and the damage to the ship avoided.

Leading points in the question of the defence of the navy, &c., from lightning, according to the method proposed by Mr. Snow Harris.

1st. The question is a national one, and involves some of the most important interests of Great Britain.

The power of a maritime country depends much on the security of her fleets; now, ships are not only damaged materially by atmospheric electricity, but they may be even sunk, burned, or otherwise destroyed by it: thus, the nation may be deprived of the full services of her fleets at a critical moment.

2. Ships have been continually damaged by lightning, whilst buildings on shore have been effectually protected by lightning rods.

The frightful cases of damage detailed in the logs of the navy alone, since the year 1786, are worthy of investigation. Since the new conductors have been under consideration, many of her majesty's ships not fitted with them have been severely dealt with. In the Mediterranean, in little more than 12 months, three line-of-battle ships, a frigate, and a brig, were more or less disabled. At another time, the Southampton of 64 guns narrowly escaped being blown up: other damage to her majesty's ships, in various quarters, has also occurred; and of the large New York packets to Liverpool, several have been actually burned and lost.*

3. Inapplicability of inflexible metallic rods to the masts of ships.

The continuous and inflexible rods of Franklin having been found inapplicable to the variable conditions of a ship's mast, small links of wire, under the form of chains, have been substituted, so as to be applied temporarily from the mast head; they are usually packed in boxes, and most commonly remain unemployed in the ship's hold or store: they are found very troublesome to the seamen, and can scarcely be preserved in place during heavy gales of wind of a dark night, and on difficult and trying occasions; beside which they are of *small* electrical capacity, and too flimsy for the important office they have to perform.

4. Mr. Harris in the year 1820 submitted a proposal to the lords commissioners of the admiralty, through the comptroller of the navy, by which continuous and fixed conductors of electricity might be employed on ship-board; and further shewed, that by the system he proposed, ships might be rendered even *more secure* from lightning than stationary elevations on shore.

* Several of her majesty's ships have suffered by lightning since this paper was submitted to the first lord of the admiralty.

Mr. Harris's system consists in identifying with the masts a continuous line of copper, in two laminæ of copper sheet, from the truck to the keelson, and finally connecting it with the masses of metal in the hull and with the sea; thus insuring a permanent means of discharging into the water any accumulation of electricity in the atmosphere as yet experienced. The advantages of this system are manifest.

- 1st The metallic plates inserted in the masts have great electrical capacity
- 2nd They give stability to the masts.
- 3rd They are always in place, and hence, ready to meet the most unexpected danger.
- 4th The standing or running rigging is in no way interfered with, whilst the perfect continuity of the conductor is insured under all circumstances.

5. Mr. Harris's proposals were submitted to a committee of the Royal Society, who reported on them; and the late Dr. Wollaston, whose eminence in science is well known and appreciated, gave them his unqualified approval.

The report of the Royal Society stated, that no objection existed to the use of the new conductors, and recommended that if they terminated in the keel, they should terminate in a mass of copper considerably thicker than usual, which was originally intended. Dr. Wollaston, one of the committee, in a letter written with his own hand, thus expressed his opinion:—

“In reply to the enquiry whether I see any danger, insecurity, or liability to objection in the method proposed by Mr. Harris, of carrying off lightning from ships by fixed conductors, I certainly ought unequivocally (as far as my opinion may go) to express general approbation of his proposal. Mr. Harris appears to be well acquainted with the subject, and fairly to estimate the powers of the element with which we have to contend, and the means of directing it with as little injury as may be to surrounding objects.”

Several other men of high scientific reputation have since given the measure their support; amongst those may be mentioned Faraday, Brewster, and Turner.

6. After much damage had occurred, 10 ships were ordered to be prepared with the new conductors, including line of battle ships, frigates, and corvettes. A small brig of 10 guns was also subsequently fitted; thus the conductors have been tried in the British navy, from the largest to nearly the smallest ship in it.

These ships have all been at sea, and nearly all more or less exposed to severe lightning. In some cases they have been actually struck by the electric fluid with impunity: no case of damage has in any instance occurred, or have the conductors ever been found inconsistent with the duties of a ship's mast. Thus the *Beagle* after a service of 5 years in the south seas, has again proceeded with the same masts and conductors on an equally long voyage. The result therefore has shewn, that what Mr. Harris advanced was not only sound in philosophy but available in practice, and it hence appears quite within the range of practical science, to effectually defend our shipping against the unsparing effects of lightning.

7. No reason has ever been given for not continuing the use of the conductors in the navy.

Notwithstanding that the conductors have been for more than ten years in operation; that they have been found efficient; that no damage has in any case arisen in any vessel fitted with them; that officers in her majesty's service have repeatedly applied for them, being satisfied of their value: still, the ships in which they have been placed, have been nearly all dismantled, and the conductors put aside without enquiry. Thus, a great national experiment has been abandoned without any assignable cause—without investigation; an experiment of vast consequence to the commercial and naval prosperity of Great Britain, and to shipping generally: one which had repeatedly occupied the attention of the scientific part of Europe for more than half a century.

8. Although no good argument has been ever advanced against the general use of the conductors, yet false notions about them have not unfrequently been put forth as substitutes. These however have generally vanished, when the facts themselves have been examined. The experience of ten years of the conductors in the navy, leaves nothing further to be desired.

There is really no ground of fair objection to the conductors, whether relating to the safety of the service, applicability to the masts, expense of the application, or expediency. The evidences relating to either of these points are complete. It has been said, however, that we have only negative proofs of their value, but surely the documents relating to this point afford positive evidence. Those who say we have only negative proof do not reason logically, or according to the evidence of which the case admits. They should remember that it is the great property of the lightning rod, efficiently applied, to disarm as it were the fury of strokes of lightning, so as either to avoid altogether the devastation resulting from a shock of lightning, or otherwise greatly parry it. In the language of Sir H. Davy, "the thunder-cloud is disarmed of its terrors, and the lightning discharged in harmless coruscations." We may cite the cases of the *Beagle*, *Sapphire*, and *Dryad*, as further evidence of this fact: we have, therefore, before us all the evidence of which the case admits; at all events it must be allowed, that since a great number of vessels fitted with the conductors have been exposed to severe lightning, and have been struck by the electric fluid,—and that in no case has any damage occurred, the conductors are at least harmless. It has been likewise erroneously observed, that damage by lightning is very partial, and not upon the whole, deserving any great attention; a remark evidently arising from the circumstance that the damage occurs at different times, and in places widely apart, and to individual ships, many perhaps not again heard of. If, however, we look at the cases of damage by lightning on ship-board, we shall find them by no means uncommon; the argument against the conductors upon this ground seems very beside the question. It is not admitted in other articles of a ship's equipment calculated to save life and property: the use of the life-buoy, for example, is never objected to on the ground that the number of cases in which it is called for are small compared with the whole number of ships and lives at sea: it may be, that for the last year no vessel has had occasion to use a life-buoy, or even let go her sheet anchor;

but we are yet to learn that this is admissible as an argument for not furnishing ships with these protectors of life and property; the question fairly stated would run thus;—does not experience shew, that a ship may be totally destroyed by lightning, and the country deprived of the full operation of her fleets at a critical period? Is not, in fact, *life, property, and national power* involved to a greater or less extent? If so, ought we to hesitate or grudge the little trouble and expense requisite to free our shipping from this fearful contingency?

9. It must be admitted as being somewhat paradoxical, that whilst the principles of lightning conductors are admitted, and conductors employed in powder magazines and other government departments; and even furnished under the imperfect form of small chains to ships, they should not be adapted in ships under the best possible and most efficient form they can be used.

If the general utility of lightning rods were altogether denied, and the principles upon which they are applied, questioned, then we might understand the consistency of hesitation about Mr. Harris's proposals; but since this is not the case, and that Mr. Harris's conductors stand on common ground with those already employed in the public service, the paradox is not a little curious—it, in fact, amounts to this;—lightning rods are very important for high buildings and powder magazines; nay, are even very useful under the imperfect form of small chains to ships; but we question their utility in ships when applied in the best possible way according to the admitted principles from which they derive all their value.

10. The question is now reduced to this;—experience having shewn that it is possible to defend the navy and shipping of Britain—the right arm of her power—against one of the most unsparing and destructive agencies in nature. Query—Is it worth while to do so?

This is actually the point to which we are reduced by the results:—do we require the opinions of men of scientific learning, then we have the recorded opinions of Sir H. Davy, Dr. Wollaston, and Sir David Brewster: we have the avowed sentiments of Faraday, Turner, and others; and the approbation of almost every man of practical science who has considered the question. Do we require evidence from experience?—We have the conclusive facts deducible from ten years' experience in eleven ships at least, in which the conductors were fitted. Do we consider the matter on the ground of economy?—We possess estimates of expenses, with plans, &c. by naval engineers expressly employed by the admiralty in determining this point; and all of which go to shew the expense is small. Do we view the question on the ground of expediency? We have the frightful damage before us sustained by our fleets, the loss of life &c. Hence there is no point not capable of a satisfactory and definite position.

11. It is submitted that Mr. Harris's position in respect of this question is not undeserving fair consideration: a subject of great practical benefit to our marine has been successfully advanced through his exer-

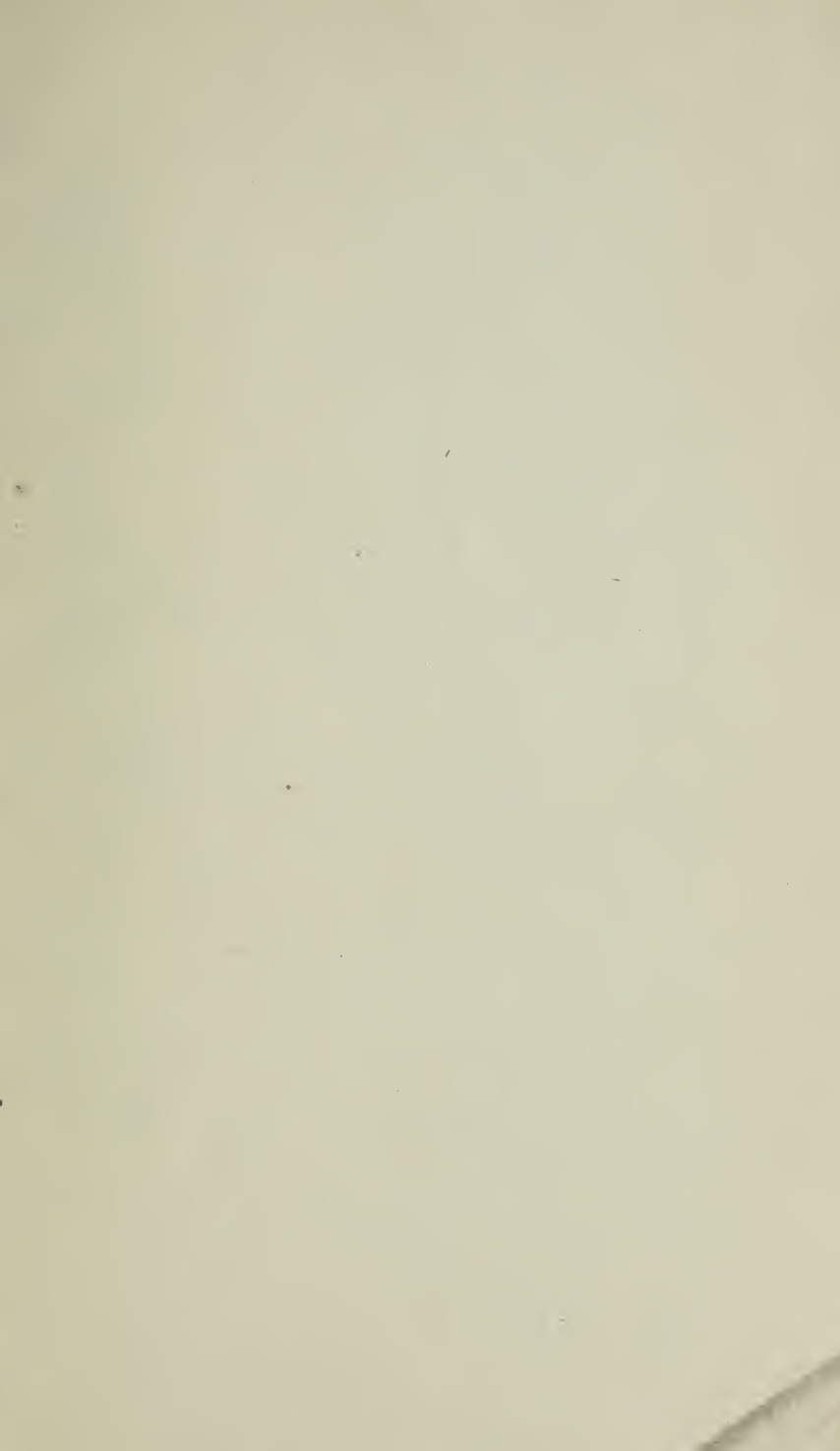
tions, and at a great pecuniary sacrifice; and that too under the immediate sanction of the government. Beside being officially directed to proceed in the affair of the new conductors, he has been also called upon to see the common conductors more efficiently applied, and to superintend and set up according to his own plan the lightning conductors at the new Victualling Office at Plymouth. Thus he has not only incurred great expense, but a heavy responsibility.

It must be admitted as a fair axiom, that a national benefit is entitled to national consideration; and that personal responsibility deserves some fair acknowledgment. If any damage had occurred to either of the ships fitted with the new conductors, or in the Ordinary at Plymouth, or to the tower at the new Victualling office, Mr. Harris would have been doubtless held responsible.

The report from the *Beagle* shews, that the conductors had performed their office and defended the ship; this, it must be allowed, was of the utmost, perhaps vital importance to the survey on which she was employed; since, if the vessel had been struck by lightning, it is more than probable that the many valuable chronometers, compasses, and philosophical instruments of various kinds, necessary to the survey, would have been seriously damaged; the cabin set apart for the charts not being far from the main-mast. The damage done to the packet-ship *New York* is highly illustrative of this: it should be further remembered that this is not a solitary instance. If the country has benefitted by Mr. Harris's exertions, is it just that his reward should be not only a total neglect of his proposals, but a great pecuniary loss? It may be observed, that remuneration has been granted for the expenditure of time, thought, and private means, in perfecting inventions of far less importance than this, the object of which, is to preserve those costly floating structures employed in our national defence and prosperity, as well as the lives of those on board, from one of the most terrible casualties to which they are exposed.

12. It is therefore further submitted, that Mr. Harris may justly claim to have these circumstances fairly considered. In seeking for an enquiry, he aims at nothing which may not come openly and fairly before the country, without any kind of reservation whatever.

The British legislature has not unfrequently evinced, by pecuniary rewards of various kinds, its good feeling for literature and science: if this has been done in individual cases, upon the general ground of literary or scientific distinction, surely it must be deemed at least equitable to consider those, who possessing, although in a less degree, similar claims, have at great personal sacrifice succeeded in the perfecting an application of practical science, most important to the navy of England, and to shipping generally.







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